Nano BioPhotonics

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Nano BioPhotonics

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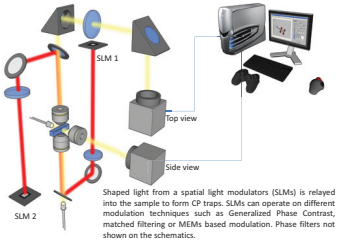
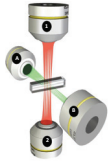
BioPhotonics Workstation (BWS)

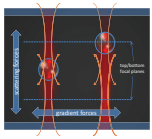


Shaped light from a spatial light modulators (SLMs) is relayed into the sample to form CP traps. SLMs can operate on different modulation techniques such as Generalized Phase Contrast, matched filtering or MEMs based modulation. Phase filters not shown on the schematics.

The long working distance allows an extra microscope to be mounted perpendicular for side view or for an independent optical setup. The laser source is modulated and shaped by a single spatial light modulator; the upper and lower parts of the beam are separated and projected into the sample from opposite directions. Traps patterns from SLMs are relayed into the sample through a 4f geometry. A periscopic design, with two mirrors in each arm, simplifies the necessary optical alignment.

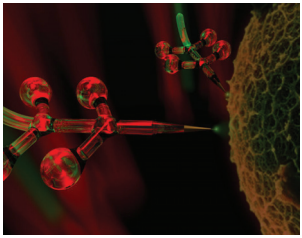
Forces on counter-propagating traps



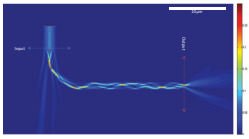


The counterpropagating based workstation geometry achieves particle trapping in the x-y (transverse) plane due to gradient forces and z (axial) trapping due to equilibrium between the scattering forces caused by a set of counterpropagating beams. Changing the top and bottom beams' relative intensities causes axial translation. Axial positions can be stabilized via dynamic feed back based on machine vision.

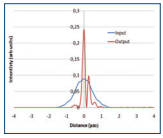
Wave-guided optical waveguides (WOW)



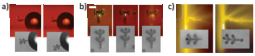
Wave-guided optical wave guides (WOW): Optically maneuverable strongly confined and intense light sources. Combined with the BWS, WOWs enable advanced biological research through localized stimulation or sensing.



FDTD simulation showing wave guiding through the microtool. A wavelength of 532nm and refractive indices of SU8 (1.6) and H_2O (1.33) were used.



The light becomes narrower and more intense as it comes out of the WOW.

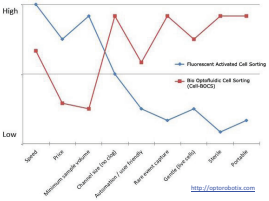


Experiments on the BWS demonstrating manipulation and light coupling on WOW: a) Probing an ~80μm bubble; b) Waveguide output towards the microscope; c) Waveguide output to the side

SEM images of 2-photon polymerized WOW and previous mechanical microtools.

Bio-Optofluidics Cell Sorter (cell-BOCS)

The cell-BOCS sorting mechanism depicting two laminar streams displaced in height. The lower stream (purple/red) contains a mixture of cells. Machine vision detected cells are pushed up to the other stream. The table top cell-BOCS has a base that is roughly A3 in size (45cm x 30cm). The chart below summarizes the BOCS's features compared to fluorescent activated cell sorting systems (FACS).



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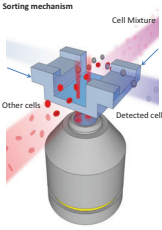
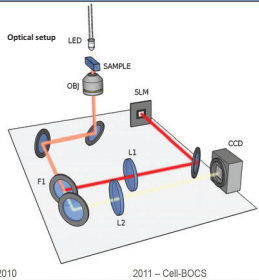
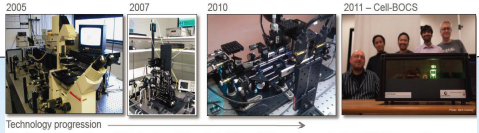




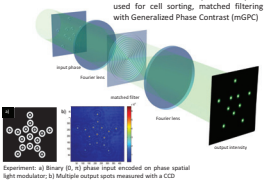


Technology progression

Development steps of cell-BOCS technology platform during 2005- 2011. From a large optical table (2005), to a medium stand alone BWS (2007), to a compact BWS prototype (2010) to a table top Cell BOCS (2011).

Matched filtering Generalized Phase Contrast (mGPC)

To further increase the power on optical traps used for cell sorting, matched filtering used with Generalized Phase Contrast (mGPC)



Experiment: a) Binary (0, π) phase input encoded on phase spatial light modulator; b) Multiple output spots measured with a CCD

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